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DEVICE FOR THE LEAK-TIGHT SEALING OF PACKAGING CONTAINERS  
FOR SENSITIVE PRODUCTS

Domain of the invention

The invention relates to a device for the leak-tight sealing of openings in containers and for the purification treatment of ambient air located therein as a result of opening and closing cycles, these containers being intended for packaging of products that are sensitive to gaseous pollutants present in this ambient air.

The invention is related particularly to a device for leak-tight sealing of the access opening in containers and for purification treatment of ambient air located in these containers as a result of opening and closing cycles, these containers being intended for packaging of products sensitive to gaseous pollutants. This leak-tight sealing and purification treatment device is composed of the following, according to a new combination of known or unknown means:

- a leak-tight sealing means in the container access opening,
- a means of assembly of the sealing device on the container access opening,
- a means of connection between the sealing means and the assembly means of the device,
- at least one means of checking tamper resistance
- a mechanical assistance means controlling the amplitude of the opening angle and assisting with opening and closing of the said sealing means.

The leak-tight sealing and purification treatment device is a single part made of thermoplastic materials using plastics technologies.

In the following and throughout the description of the object according to the invention:

- The gaseous pollutants that may be present in the ambient air in the leak-tight packaging containers for sensitive products may for example be water vapour, oxygen ( $O_2$ ), ammonia ( $NH_3$ ), alcohols, aldehydes, ketones, sulphur dioxide ( $SO_2$ ), hydrogen sulphide ( $H_2S$ ), mercaptans, alkenes particularly including ethylene, alkynes, carbon dioxide ( $CO_2$ ), carbon monoxide ( $CO$ ), nitrogen dioxide ( $NO_2$ ), alkanes and particularly methane ( $CH_4$ ), halogens and particularly fluorine, bacteria in suspension in the ambient air and others.
- Products sensitive to gaseous pollutants present in the ambient air may be defined as being:
  - materials in the solid state, in a wide variety of forms such as powdery, granules, pellets, particularly for effervescent, sugar-coated or agglomerated products, and / or
  - objects that may be in various shapes and particularly oblong shapes.

Thus, and according to this definition:

- Materials sensitive to pollutants like those mentioned above to be packaged in a leak-tight container are usually medicaments, particularly effervescent medicaments, that should be protected so that their reactive effectiveness does not change in time due to reaction with at least one of the pollutants, and / or so that their physical integrity is maintained in the long term, and for example to avoid a change to their mechanical cohesion.

- Objects sensitive to pollutants, to be packaged in a leak-tight container are particularly oblong in shape, and they may have an approximately polygonal, circular, elliptical or elongated cross-section and are consumables.
- 5 Such objects include particularly small tongues, reactive bands or rigid lamellae used for example for diagnosis or checking purposes in the medical field, dressings, food products such as chewing-gum, tooth picks, small sticks or others.

10 For obvious reasons, particularly hygiene reasons but also to prevent any degradation and thus improve the conservation life of products sensitive to pollutants present in ambient air, these products are placed in containers protected from physicochemical attacks caused by  
15 the concentration of gaseous pollutants, but also protected from light, particularly UV rays, or from degradation due to mechanical causes such as shocks.

#### State of the art

20 Establishment of the state of the art demonstrates the existence of stoppers for closing containers, the essential function of which is that they have drying properties: these particular containers are designed to receive and contain products sensitive to ambient humidity, that must be  
25 protected by creating the driest possible internal ambient atmosphere to prevent a regain of humidity, since such regain of humidity by absorption could in particular react with the said products and reduce their reactivity causing mechanical weakness under shock, spalling or disintegration  
30 in the container.

Many products are particularly sensitive to ambient humidity, and for example and more precisely may include medicament test materials in powdery form or in more sophisticated forms such as granules, tablets, pellets, 5 oblong shaped objects such as bands for tests or other purposes, more specifically including products that are particularly sensitive to humidity.

These drying and leak-tight containers according to the state of the art for the storage of products sensitive to 10 ambient humidity are tubular shaped or may be in any other shape and, provided with an opening, are closed off by a stopper that may or may not be fixed to the tubular part through a solidarisation means such as a narrow flexible strip made from a polymer material identical to the material 15 from which the container and the stopper are made.

These drying and leak-tight containers are provided with internal drying means that are either a coating or insert made using a drying thermoplastic polymer composition placed inside the containers on the inner surface of the 20 bottom of the tube and / or on the inner surface of the sidewall of the tube, or a drying granular material placed in a particular housing on the inner surface of the stopper.

All these drying means are put into place separately or simultaneously to increase their dehydrating efficiency due 25 to a mass effect.

These closed containers are formed from:

- a tubular casing provided with a bottom at one of its ends, the other end being left open so that the said casing can be filled,
- 30 • and a closing means that may be a removable stopper that fits into the open end of the tubular casing, or a

stopper-cap that also fits into the open end but is connected to the tubular casing by a flexible link such as a narrow flexible polymer strip acting as a hinge.

5 All these containers and their removable or connected closing means are made from thermoplastic polymer compositions according to techniques well known in plastics techniques.

Means of sealing containers and the drying containers 10 closed by these means for packaging materials and / or objects sensitive to ambient humidity, are described in the state of the art and are distinguished from each other essentially by their architecture, particularly by drying means used in the said containers and by the architecture of 15 the container closing means.

According to a first type of drying container sealing means used in the state of the art, this first closing means is a male type stopper-cap connected to the tubular part of the casing of the drying container through a mechanical 20 means composed of a force fitting ring surrounding the said tubular casing and a flexible and narrow connecting strip between the stopper-cap and the ring, the drying container being formed from a tubular casing open at one of its ends to provide access to the receptacle area.

25 A document (US P 4 934 556) describes such a sealing means and a drying container closed by this means, the closed assembly forming the container being composed of:

- a sealing means comprising a male type stopper-cap, a ring for a force fitting of the said stopper-cap on the 30 tubular casing of the container, a tamper resistance telltale to be torn off, connecting the assembly ring

to the outer periphery of the stopper-cap and a flexible strip acting as a narrow connecting hinge between the stopper-cap and the said ring, the sealing means being made from a thermoplastic polymer material  
5 that may be different from the material used to make the tubular casing;

- a tubular casing made of a thermoplastic polymer material, provided with a bottom at one of its ends and open at other end, acting as a receptacle for the  
10 materials to be packaged, on which the sealing means is installed through the ring.

The male type stopper-cap is formed from a bottom and a descending peripheral skirt called the outer skirt that  
15 delimit a cylindrical cavity inside which there is a housing containing a powdery drying agent in direct contact with the internal gaseous medium to be dehydrated.

The sealing means comprising the stopper-cap, the force fitting assembly ring, the tamper resistance telltale, and a  
20 single, flexible, narrow connecting strip connecting the stopper-cap to the ring forms an assembly made of a thermoplastic polymer material independent from the tubular casing forming the receptacle of the drying container.

This type of drying stopper-cap designed to close a  
25 tubular casing used for packaging of products sensitive to humidity raises uncertainties about its capability to guarantee fast and complete desiccation of the said products when opening / closing the said packaging container. This fact appears to be:

- 30 • the result of insufficient leak-tightness between the male type stopper-cap and the tubular casing, since the

architecture of the said stopper-cap does not appear to be suitable for making the container leak-tight when external - internal exchanges of gaseous volumes containing humidity that should be quickly dehydrated;

5       • also, at least partly, the consequence of the flexible connecting means between the cover-cap and the force fitting ring surrounding the casing, since it is impossible to achieve correct positioning of this means consisting of a narrow flexible strip made of a polymer material acting as a hinge when closing the casing, due  
10       to lack of any guidance prior to the said closing.

This type of stopper-cap also requires a manipulation of the closed container with two hands, both to open it and to close it.

15       Another type of drying container sealing means known in the state of the art is a female type stopper-cap fixed to the drying container casing through a means consisting of a narrow flexible connecting strip, the tubular casing, the stopper-cap and the connecting means being made by injection  
20       with the same thermoplastic polymer material.

A document (EP 1 352 844) describes such a type of drying container closing means, the closed assembly forming the container being composed of:

25       • a tubular casing made of a thermoplastic polymer material provided with a bottom at one of its ends and open at the other end;

30       • a female type stopper-cap without a descending inner skirt that covers the wall of the open end of the container casing when in the closed position, leak-tightness being capable of being assured by the contact between the inner surface of the bottom of the cap of

the stopper-cap and the periphery of the open end of the tubular casing, the said stopper-cap being provided with a perforated cavity on its inner surface into which a drying agent in pellet form can be added and connected to the casing through a link consisting of a narrow flexible polymer strip, the casing, the cap and the connection between the cap and the casing being made in a single part during a single plastics forming operation, for example by injection moulding;

- 10     • a drying insert consisting of a thermoplastic polymer material containing drying materials, this insert possibly covering the bottom and the inner wall of the said casing simultaneously;
- 15     • the stopper-cap without a descending inner peripheral skirt cannot create a surface-to-surface type leak-tightness with the inner surface of the open end of the tubular casing, leak-tightness is apparently only obtained through contact between the inner surface of the bottom of the stopper-cap and the periphery of the open end of the casing;
- 20     • the stopper-cap is not particularly suitable for creating leak-tightness between the inside and the outside of the container due to its architecture, but also due to its flexible connecting means with the casing, since this means cannot be used to position the cap when it is closed due to this very high flexibility and consequently the lack of sufficient longitudinal and lateral mechanical stiffness necessary for guidance of the stopper-cap at the time that it is closed;
- 25     • it requires the use of two hands to manipulate the closed container for opening and closing.

Another document (GB 2 224 309) describes a hinged sealing device, in other words a stopper for a thermoplastic container and more particularly for containers comprising a very narrow, coaxial distribution opening and intended for 5 distribution of liquid. The stopper comprises a tubular peripheral wall on the inner surface of its upper end with a section adapted to the section of the narrow distribution opening to be sealed, and making the stopper leak-tight when the stopper is in the closed position.

10 The said device is composed of two parts, the first part being a click fitting cap pivoting on two hinges composed of two flexible strips defining a first rotation axis, the second part being a base to be fixed on the opening of a container to be sealed, and a flexible and 15 elastic link making the connection between these two members and being such that the stopper can occupy two rest positions, one closed and the other open, on each side of an intermediate position occupied during the movement.

12 The said flexible link with a return function is "S" shaped and is connected semi-rigidly and elastically firstly to the stopper at a precise point, and secondly to the outer surface of the base at another precise point. The connection between the ends of the flexible link firstly to the stopper and secondly to the outer surface of the base is 25 characterised by the lack of hinges due to the continuity of the thickness of the wall.

13 However, this device has several disadvantages that can be the result of a form of embrittlement of the material forming the flexible link. The "S" shape of the flexible link when the device changes from a closed position to an 30 open position contributes to creating two opposing forces

about an inflection point located approximately at the middle of the flexible link, this inflection point delimiting a convex area of the strip on the downstream side and an area of the strip on the upstream side that remains 5 concave.

Thus, the slope inversion due to the "S" deformation at the time of closure causes an acceleration of the movement acting on the convex part of the strip, in other words between the cap and the inflection point, to restore the 10 initial stable concave state of the entire strip.

Therefore this type of flexible link performing the return function is deformed by the slope inversion over its entire length, this total and constant mechanical mobilisation of the material from which the flexible link is 15 made tending to weaken it.

Thus, apparently none of the drying stoppers-caps according to the state of the art is adequate for packaging products sensitive to relative humidity and / or other gaseous pollutants in appropriate containers under optimum 20 conditions, and to enable these containers to develop remarkable characteristics such as:

- quickly absorbing humidity and / or gaseous pollutants, particularly the pollutants mentioned above in a container even after a fast opening / closing cycle,
- 25 - easy manipulation of the said stoppers-caps with a single hand and keeping the container sealed, and
- providing mechanical assistance with opening / closing the stopper-cap.

Objectives of the invention

Many objectives are assigned to the leak-tight sealing device according to the invention for packaging containers and for purification treatment of the ambient air located in 5 the container by elimination of the gaseous pollutants present, such that it minimises the above mentioned disadvantages and provides appropriate solutions better than the solutions provided with the various means used in sealing devices described in the state of the art.

10 Some of the most important objectives of the sealing device according to the invention for packaging containers for products sensitive to gaseous pollutants are means that in combination assure:

- easy opening / closing of the leak-tight sealing and 15 treatment device by precise mechanical guidance of the sealing means so that sealing takes place precisely with no manual guidance, with excellent positioning,
- mechanically assisted opening / closing of the leak-tight sealing and treatment device to accelerate 20 opening and closing of the sealing means and to limit the amplitude of the opening angle at the end of travel so as to put the sealing means in a suitable position for closing with the use of a single finger of the hand holding the container,
- complete leak-tightness set up between the opening to 25 be closed and the sealing means,
- at least one tamper resistance means of the container before first opening,
- dynamic treatment of gaseous pollutants, and 30 particularly the water vapour present in the container, better than what is observed in the state of the art,

in other words with a greater capacity to eliminate internal pollution created when the container is opened and closed, to prevent packaged products sensitive to gaseous pollutants from adsorbing and / or reacting partly with the said pollutants and an ability to keep the content of gaseous pollutants internal to the container at a low and relatively constant level, except during opening / closing cycles, to provide the best possible protection to the packaged products sensitive to these pollutants.

#### SUMMARY OF THE INVENTION

All of the objectives mentioned above can be achieved by the device for leak-tight sealing of containers and 15 purification treatment of ambient air in the containers used to package the fabricated or other products sensitive to gaseous pollutants.

According to the invention, the device for leak-tight sealing and purification treatment of ambient air in the 20 packaging containers for products sensitive to ambient pollutants, with controlled amplitude of the opening angle and with mechanically assisted opening and closing, made from thermoplastic polymer materials, to be installed on the tubular casing of the access opening to the said containers, 25 comprises:

- a leak-tight sealing means of the access opening of the container, with a means of packaging ambient air treatment agent(s), on its inner face
- a means of assembly of the sealing means onto the 30 tubular casing of the access opening,

- a connection means between the sealing means and the assembly means,

- a first opening tamper resistance means, placed between the sealing means and the assembly means,

5 and is characterised in that it comprises:

a) a male type stopper-cap as the sealing means of the opening in the tubular casing of the container, composed of an upper end wall on which a first coaxial peripheral wall is mounted setting up a leak-tight contact with the inner 10 surface of the tubular casing of the container access opening, and a second wall internal to the first wall, forming the packaging means for the ambient air treatment agents,

b) as the assembly means of the sealing means, an 15 assembly ring mounted on the tubular casing of the access opening, the inner face of which is provided with a means of attachment of the outer face of the casing,

c) as connection means between the assembly means and the sealing means, two distinct hinges at a spacing from 20 each other,

d) as first opening tamper resistance means, a peripheral series of connecting micro-dots or a peripheral strip to be torn off, or a combination of these two means placed between the sealing means and the assembly means,

25 e) a mechanical assistance means for opening and closing and controlling the amplitude of the opening angle of the sealing means, placed in the space located between the two hinges and simultaneously connected to the stopper-cap through a film hinge, and to the attachment ring 30 fastening the device onto the casing by another film hinge,

the section through the said mechanical assistance means being in the form of a bracket.

Detailed description of the invention

5 The various objectives assigned to the object of the invention are the result of insufficiencies demonstrated during use of drying containers according to the state of the art for packaging of products sensitive to ambient humidity and sealed by stoppers-caps fitted with film  
10 hinges.

Among these insufficiencies that occur in containers and their sealing device according to the state of the art, the following latent problems are observed:

15 - impossibility of gripping the container and controlling opening and closing of the stopper-cap with a single hand, particularly to remove one of the first opening tamper resistance telltales,

20 - absence of mechanical assistance to facilitate opening and closing of the stopper-cap and to control the amplitude of the opening angle of the stopper-cap at the end of its travel distance,

25 - the lack of precise guidance of the stopper-cap through the use of a flexible hinge as the connecting means between the container and the stopper-cap, that is incapable of assuring suitable positioning of the said stopper-cap at the moment that the container is sealed,

- the more or less fast capability of treating gaseous pollutants present in the ambient air inside the container during opening / closing cycles of the container and

30 - the efficiency of the sealing means in terms of leak-tightness between long frequency opening / closing cycles to

prevent gas / gas exchanges between the inside and the outside of the closed container that could cause a variation of the relative humidity and the content of other gaseous pollutants inside the container.

5 All these latent problems are solved in the sealing and treatment device according to the invention through a new combination of known or unknown means.

According to the invention, the sealing and purification treatment means created for the container is of 10 the male type, as recommended in the state of the art, but is quite different from the state of the art due to the fact that its new architecture assures a peripheral area of intimate contact with the inner surface of the tubular casing forming the opening of the container to be closed, 15 this area of intimate surface-to-surface type peripheral contact forming an efficient barrier to obtain and to maintain internal leak-tightness of the container.

To achieve this, the chosen sealing means is of the stopper-cap type comprising an upper end wall forming the 20 ceiling of the stopper-cap with a section adapted to the section of the tubular casing that it is to close. This upper end wall is provided with two walls, one called the outer wall and the other called the inner wall, that are peripheral and tubular, concentric and coaxial with the 25 tubular casing.

The first peripheral and tubular wall called the outer wall, creates an intimate peripheral contact area to obtain a surface-to-surface type leak-tightness by setting up a leak-tightness barrier between the inner face of the tubular 30 casing of the access opening and the outer face of the said first wall called the outer wall, of the stopper-cap.

The shape of the cross-section of this first wall called the outer wall comprises a peripheral swelling facing outwards that will come into contact with the inner wall of the tubular casing of the container opening.

5 When the sealing means or stopper-cap is in the closed position, the peripheral swelling in the first wall called the outer wall is forced into contact with the inner surface of the tubular casing of the opening, preferably being deformed or compressed to a certain extent which increases  
10 the contact surface area of the peripheral swelling with the inner surface of the tubular casing of the opening of the container such that the surface-to-surface contact that is firstly tangential may become intimate and immediate during closing by an increase of the contact surface area resulting  
15 from sliding and compression of one wall on the other wall, reinforcing the leak-tightness between the sealing device and the container.

An efficient leak-tightness is then set up between the inside and the outside of the container closed by the  
20 sealing means according to the invention.

The second wall called the inner peripheral and preferably tubular wall forms an appropriate housing that will contain one or more purification treatment agents, the particular position of this housing being of overriding  
25 importance to increase the treatment rate of gaseous pollutants and particularly water vapour.

This appropriate housing, preferably of the tubular type, is located on the inner face of the sealing means or the stopper-cap and is closed by a closing means that is not  
30 leak-tight to gaseous pollutants, to assure fast elimination

of these pollutants from the container in which the sensitive products to be protected are packaged.

The choice of a drying agent is also of overriding importance so that the container closed by the leak-tight sealing and treatment means according to the invention is very effectively drying in the special case of the treatment of water vapour.

According to the invention, the drying agent used in the container closed by the leak-tight sealing and treatment means is chosen from the group composed of silica gels, molecular sieves in powdery form or deposited on a powdery support.

Known treatment agents appropriate to each pollutant are used in the appropriate housing created on the bottom inner part of the leak-tight sealing and treatment means so that the container closed by the leak-tight sealing and treatment means according to the invention is equally efficient with regard to gaseous pollutants other than water vapour:

- 20        - either mixed with the drying agent,
- or separately from the drying agent by creating open compartments in this appropriate housing separating the said housing into sectors each designed to contain a separate treatment agent or mixes of treatment agents compatible with
- 25    each other.

To facilitate the stopper-cap opening and closing manoeuvre, the plane lower edge of the outer peripheral wall may be extended by a gripping visor.

A child safety opening system can be installed adjacent to the visor, to make it difficult or impossible for children to open the stopper-cap. This device, which may for

example be a flexible strip forming an integral part of the assembly means is located underneath the visor such that the projection from the visor used to apply a vertical thrust to open it is surrounded by this flexible strip.

5 In this case, the visor cannot be accessed until pressure is applied on this strip in order to deform it and provide access to the said visor. With this type of means, the child is protected by the fact that two complementary actions have to be performed simultaneously, the first being  
10 a horizontal pressure on the flexible strip, and the second being a vertical upwards thrust on the released visor by maintaining pressure on the flexible strip.

The inner face of the outer wall of the stopper-cap approximately facing the gripping visor and the outer face  
15 of the outer wall of the tubular casing of the access opening of the container are provided with a click fit means, requiring a mechanical force both to close the stopper-cap with reinforced leak-tightness and to open it, to keep the stopper-cap in the closed position after it has  
20 been opened at least once.

According to the invention, the assembly means of the sealing means or the stopper-cap is formed from an attachment ring mounted on the tubular casing of the access opening to the container to be sealed, this ring:

25 - being sized to match the dimensions of the tubular casing,  
- being provided with a click fit means either recessed or in relief on its inner face that will come into contact with the outer surface of the casing, the click fit means  
30 facing the outer face of the casing on which there is an

opposed mating means used for click fitting the ring, in other words it is in relief or is recessed,

5 - if it is not provided with a click fit means on its inner surface, being accurately adjusted to the size of the casing and force fitted onto the casing, or fixed by a bonding means.

According to one variant of the invention, the outer peripheral surface of the tubular casing of the access opening to the container to be sealed comprises two 10 projecting peripheral collars separated from each other, creating a groove with an approximately rectangular shaped section such that:

- the thickness of the tubular casing inside the groove is not modified, and
- 15 • the attachment ring is force fitted into the said groove.

According to another variant of the invention, a 20 peripheral groove that may have an approximately rectangular, hemispherical or semi-elliptical shaped section, is made recessed within the thickness of the wall of the tubular casing of the container such that:

- the thickness of the tubular casing inside the groove is modified, and is less than the thickness of the 25 tubular casing and
- the attachment ring is force fitted into the said groove.

According to another variant of the invention, the 30 inner surface of the attachment ring is provided with click fit means which, when the said attachment ring is force

fitted into the groove of the tubular casing of the container, itself equipped with complementary click fit means, fit into the corresponding click fit means so as to block any rotation or translation of the stopper with 5 respect to the container.

The said click fit means present on the inner surface of the attachment ring and on the inner surface of the groove of the container may be of various types such as splines, slots, or others.

10 According to the invention, a relatively rigid hinge type connecting means is present between the sealing means (or stopper-cap) and the assembly means (an attachment ring) on the tubular casing of the access opening to the container.

15 The hinge type connecting means according to the invention is formed from two film hinges at a distance from each other, making the connection between the stopper-cap and the attachment ring rigid due to their spacing.

20 Each film hinge is formed from two parts connected together by a polymer film acting as an axis of rotation to enable opening - closing cycles of the sealing means, one of the parts being integrated into the sealing means and the other part being integrated into the assembly means.

25 The two parts of each of the two hinges integrated into the sealing means and into the assembly means form attachment brackets for the two film hinges on the sealing means and the assembly means.

30 These two types of film hinges assure optimum operation during closing (and during opening) and during placement of the stopper-cap on the casing of the opening to be sealed using a single finger of the hand holding the container, due

to perfect mechanical guidance of the said stopper-cap not requiring any pressure for closing other than a downwards vertical pressure, which causes click fitting of the stopper-cap. Note that according to the state of the art, 5 two hands are necessary to close or open removable stoppers or stoppers-caps connected to the tubular casing by a single film hinge.

These two film hinges at a spacing from each other form a precision hinge for closing the drying stopper-cap since, 10 due to the rigidity that they create due to their spacing, they guide the drying stopper-cap along a perfect path until it is completely closed, leading to click fitting of the stopper-cap by applying a simple vertical pressure.

According to the invention, the tamper resistance means 15 or the tamper resistance telltale consists of:

- either micro-links connecting the lower peripheral surface of the stopper-cap to the upper peripheral surface of the attachment ring, these micro-links being micro-connection dots independent of each other but forming a 20 toothed peripheral connecting ring between the drying sealing means and the assembly means on the tubular casing of the container opening, these micro-dots will be broken during the first opening by application of a breaking force exerted in the upwards direction on the visor,

25 - or a tamper resistant ring to be torn off connecting the lower peripheral surface of the stopper-cap to the upper peripheral surface at the attachment ring,

- or both of the above mentioned tamper resistance means, forming a new combination of tamper resistance means.

30 According to the invention, a mechanical spring-loaded means for assistance in opening or closing the leak-tight

sealing and treatment means is placed in the space between the two previously mentioned film hinges. The section through this mechanical means is bracket shaped with an angle of the order of 90°.

5 This spring-loaded mechanical means for assisted opening and closing of the leak-tight sealing and treatment means also controls the amplitude of the opening angle of the sealing means, such that when it at its maximum open position, the sealing means is easily moved in the closing  
10 10 direction using one finger of the hand holding the container fitted with the device according to the invention.

The spring-loaded mechanical means is simultaneously connected to the stopper-cap by a film hinge and to the attachment ring of the device according to the invention by  
15 another film hinge.

The preferred amplitude of the opening angle controlled by the spring-loaded mechanical means is not more than 160° and is usually between 90° and 160°, unlike the opening angle of a stopper-cap according to the state of the art  
20 which is about 180° and often more than this.

The section through the spring-loaded mechanical means is like a tensioned bracket. When the container is opened and closed, the mechanical means shaped like a bracket is slightly deformed at the attachment points of the said  
25 mechanical means, in other words at the stopper-cap and at the device attachment ring: the angular deformation of the bracket shaped mechanical means is the same on each side of the bracket and is of the order of not more than 15° on each side and preferably of the order of not more than 9° on each  
30 side.

The observed deformation of the angle formed by the bracket between its closed position and its open position is then between 0° and not more than 30° and preferably between 0° and not more than 18°.

5 Thus, this mechanically assisted opening or closing of the specially shaped sealing means is characterised by its excellent flexibility in operation and enables the said sealing means to be closed smoothly with no sudden jerks, and precise and controlled guidance of the stopper-cap  
10 during closing.

The leak-tight and treatment device according to the invention for leak-tight sealing of containers to be used for packaging of products sensitive to ambient humidity is composed of a leak-tight sealing and treatment means, a  
15 means of assembly of the sealing means on the opening to be closed, a means of connecting the sealing means and the assembly means, at least one tamper resistance means and a means for mechanical assistance with opening and closing the sealing means and for controlling the opening angle of the  
20 sealing means, is made in a single part by plastics manufacturing methods adapted to manufacturing using materials consisting of thermoplastic polymers and / or copolymers, for example such as polyethylenes (PE), polypropylenes (PP), ethylene / propylene copolymers and  
25 blends of them, polyamides (PA), polystyrenes (PS), acrylonitrile-butadiene-styrene (ABS) copolymers, styrene-acrylonitrile (SAN) copolymers, polyvinyl chlorides (PVC), polycarbonates (PC), polymethyl methacrylate (PMMA), polyethylene terephthalates (PET) used alone or blended  
30 depending on their compatibility.

At least one natural or synthetic thermoplastic elastomer may be associated with these polymers and / or copolymers to make the device, depending on the required mechanical characteristics. The elastomer(s) used may 5 preferably be chosen from a group composed of natural rubber or synthetic rubber type elastomers, and particularly rubbers based on olefins for example such as polymers of isobutene / isoprene, ethylene vinyl acetate (EVA), ethylene-propylene (EPR), ethylene-propylene-diene (EPDM), 10 ethylene-acrylic esters (EMA-EEA), fluorinated polymers, diolefin rubbers such as for example polybutadienes, styrene-butadiene (SBR) copolymers, rubbers based on condensation products such as for example polyester or polyurethane thermoplastic rubbers, silicones, styrenic 15 rubbers, styrene-butadiene-styrene (SBS) and styrene-isoprene-styrene (SIS) and others.

According to the invention, the leak-tight sealing and treatment device and the packaging container to be sealed may be made using polymer materials with the same 20 composition or with polymer materials with different compositions.

The invention will be better understood after reading the detailed description of the Figures given below, these Figures being provided to illustrate a particular device 25 according to the invention and are non-limitative.

Figure 1 is a perspective view of the leak-tight sealing and treatment device in the open position.

Figure 2 is a perspective elevation of the leak-tight sealing and treatment device in the closed position before 30 first opening, demonstrating the tamper resistance means.

Figure 3 is a perspective view from below of the leak-tight sealing and treatment device in the closed position, comprising a child safety opening system.

5 Figure 4 is a perspective view from above oriented on the front part of the leak-tight sealing and treatment device.

Figure 5 is an elevation view of the front part of the leak-tight sealing and treatment device.

10 Figure 6 is a perspective view from above oriented on the back part of the leak-tight sealing and treatment device.

Figure 7 is an elevation of the back part of the leak-tight sealing and treatment device.

15 Figure 8 is a diametric sectional view along the hinge-visor direction of the stopper-cap.

Figure 9 is a perspective view of the leak-tight sealing and treatment device according to the invention in the open position at 120° mounted on a container with a tubular casing.

20 Figure 10 is a perspective view of the side of the leak-tight sealing device in the open position.

Figure 11 is a detailed sectional view of the attachment of the ring to the container according to one variant of the invention.

25 Figure 12 is a detailed sectional view of the attachment of the ring to the container according to another variant of the invention.

According to Figures 1 to 10, the leak-tight sealing and treatment device for containers consists of a sealing means (1) that is a stopper-cap, an assembly means (2) of the sealing means (1) onto the access opening (4) of the

5 container (5) that is an assembly ring, and a connecting means (3) between the sealing means (1) and the assembly means (2), this connecting means being composed of film hinges (6) and (7), and finally a tamper resistance means (8) at first opening and a mechanical assistance means (9) for opening and closing of the stopper-cap (1), also controlling the opening angle of the said stopper-cap.

10 The stopper-cap type of sealing means (1) comprises an upper end wall (10) forming its ceiling, provided with two concentric and coaxial peripheral and tubular walls, one of which is called the outer wall (11) and the other the inner wall (12).

15 The peripheral and tubular outer wall (11) creates an intimate leak-tight peripheral surface-to-surface type contact zone by setting up a leak-tight barrier between the inner face (13) of the tubular casing of the access opening and the outer face of the said outer wall (11).

20 The sectional shape of this first wall (11) comprises a peripheral swelling (14) oriented outwards and that will come into contact with the inner face (13) of the tubular casing of the opening of the container.

25 When the stopper-cap (1) is in the closed position, the peripheral swelling (14) of the first wall (11) comes into forced contact with the inner face (13) of the tubular casing of the opening, and is deformed and compressed to a certain extent which increases the contact surface area of the peripheral swelling (14) with the inner face (13) of the tubular casing, the surface-to-surface contact becoming total, intimate and immediate on closing, by the wall (11) 30 sliding and being compressed on the wall (13), creating complete leak-tightness.

The second wall, called the inner wall (12), peripheral and preferably tubular, forms a housing (15) that can hold an agent for the treatment of gaseous pollutants and particularly a drying agent, the particular position of 5 this housing being of overriding importance to increase the rate at which the said gaseous pollutants are eliminated.

This appropriate housing (15) is located on the inner face of the stopper-cap and is closed by a closing means that is not leak-tight to gases to assure fast treatment of 10 the ambient gaseous atmosphere and elimination of pollutants affecting sensitive products packaged in the container.

The lower plane edge of the outer peripheral wall may be extended by a gripping visor (17), to facilitate the opening and closing manoeuvre of the stopper-cap (1).

15 A child safety opening system may be installed adjacent to the visor (17) to make it difficult or even impossible for children to open the stopper-cap. This device is a flexible strip (23) forming an integral part of the assembly means and in the form of a projection creating a gap between 20 the flexible strip and the assembly means. This flexible strip is located underneath the visor following the profile such that the projection of the visor used to apply a vertical thrust to open it is surrounded by this flexible strip if there is no applied force. In this case, the visor 25 can only be accessed after applying pressure on this strip so as to deform it and enable access to the said visor. With this means, the child is protected by the necessity to perform two complementary gestures simultaneously, the first gesture being a horizontal pressure on the flexible strip, 30 and the second being a vertical upwards thrust on the

released visor by maintaining pressure on the flexible strip.

The assembly means (2) of the stopper-cap (1) is formed from an attachment ring (2) mounted on the tubular casing of 5 the access opening to the container to be sealed, this ring:

- being sized to match the dimensions of the tubular casing,

10 - being provided with a click fit means in relief (18) on its inner face that will come into contact with the outer surface of the casing, facing the outer face of the casing on which the opposed mating means for the ring click device is located, in other words recessed means.

According to one variant of the invention shown in Figure 11, the outer peripheral surface of the tubular 15 casing (24) of the access opening (4) to the container to be sealed comprises two projecting peripheral collars (26) and (27) separated from each other by creating a groove (25), with an approximately rectangular shaped section, such that:

- 20 • the thickness of the tubular casing inside the groove is not modified, and
- the attachment ring (2) is force fitted into the said groove (25).

According to another variant of the invention shown in Figure 12, a peripheral groove (25) that may have an 25 approximately rectangular, hemispherical or semi-elliptical cross-section, is made recessed in the thickness of the wall of the tubular casing (25) of the container such that:

- 30 • the thickness of the tubular casing inside the groove is modified and is less than the thickness of the tubular casing and

- the attachment ring (2) is force fitted into the said groove (25).

5 The relatively rigid hinge type connecting means (3) is present between the sealing means (1) and the assembly means (2) on the tubular casing of the access opening to the container (4).

10 This hinge type connecting means (3) according to the invention is formed from two film hinges (6) and (7) at a spacing from each other, making the connection between the stopper-cap (1) and the attachment ring (2) rigid.

15 Each film hinge (6) and (7) is formed from two parts connected to each other by a polymer film acting as a rotation axis (19) and (20) enabling opening / closing cycles of the sealing means, one of the parts being integrated into the sealing means (1) and the other part being integrated into the assembly means (2).

20 The two parts of each of the two hinges (6) and (7) integrated into the sealing means (1) and the assembly means (2) form attachment brackets of the two film hinges on the sealing means and the assembly means.

25 These two types of film hinges (6) and (7) assure optimum operation when closing (and during opening) for the placement of the stopper-cap (1) on the opening (4) of the casing to be sealed by the use of a single finger of the hand holding the container, due to perfect mechanical guidance of the said stopper-cap, only requiring a downwards vertical pressure to close it, which causes click fitting of the stopper-cap.

30 The tamper resistance means (8) or the tamper resistance telltale is formed from micro-links connecting

the lower peripheral surface of the stopper-cap (1) to the upper peripheral surface of the attachment ring (2), these micro-links being micro-connection dots independent of each other forming a toothed peripheral connecting ring between 5 the drying sealing means and the assembly means on the tubular casing of the container opening, the ring being broken during the first opening by lifting the stopper-cap using the visor (17).

The spring-loaded mechanical means (9) for assisted 10 opening and closing of the drying sealing means (1) is placed in the space located between the two film hinges (6) and (7), and its cross-section is in the shape of a bracket.

This spring-loaded mechanical means (9) also controls 15 the amplitude of the opening angle of the sealing means (1) that in this case is at  $120^\circ$ , such that starting from its end of travel position of  $120^\circ$ , the sealing means is easily moved in the closing direction by a finger of the hand holding the container fitted with the sealing device.

The spring-loaded mechanical means (9) is 20 simultaneously connected to the stopper-cap (1) by a film hinge (21) and to the attachment ring (2) of the device according to the invention by another film hinge (22).